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(54) Title: REDUCTION OF SIDE EFFECTS OF CANCER THERAPY (57) Abstract Low doses of interferon contacted with the oral and pharyngeal mucosa of a patient in conjunction with administration of radiation therapy or chemotherapy reduces the toxic side effects associated with administration of said cancer therapy.		

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REDUCTION OF SIDE
EFFECTS OF CANCER THERAPY

5 Background and Summary of the Invention

 This invention relates to a method for reducing the toxic side effects of cancer therapy. More particularly this invention relates to the use of interferon administered in a form adapted to promote contact with the inside of a patient's mouth and pharynx to reduce the undesirable side effects resulting from the administration of radiotherapy and chemotherapeutic agents during the treatment of cancer.

15 Treatment of cancer has, over the last twenty years, been the focus of a significant research and development effort. Many approaches to cancer therapy have been investigated. As a practical matter, cancer therapy can involve use of multiple treatment methods including surgical excision, radiation therapy (radiotherapy), chemotherapy, and bone marrow transplantation (for treatment in patients with some types of hematological malignancies, particularly acute myelocytic leukemia). The specific protocol utilized to treat a given malignancy, depends on the nature, location and type of malignancy being treated. Surgical excision is the preferred method for treatment of primary circumscribed tumors. Often, however, surgical excision is combined with radiation therapy and/or chemotherapy to complete the treatment

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protocol. In instances where the malignancy is not localized or where its location lowers the probability of successful removal or excision by surgical techniques, chemotherapy and radiation therapy are often used in combination.

Chemotherapy has been shown to produce long term remissions in patients with some types of cancer, including Hodgkin's Disease, acute lymphocytic and myelogenous leukemia, testicular cancer and non-Hodgkin's lymphoma. In other types of cancer, chemotherapy has been used successfully to decrease the size of large primary tumors prior to surgery. Chemotherapy often involves the use of combinations of chemotherapeutic agents. New protocols (programs for combination drug treatment) are being developed and tested continuously by the medical research community.

Anti-tumor agents are drugs which, in addition to killing tumor cells, can and do damage normal tissue. Even with the extensive research that has been conducted to define dosage levels and scheduling of drug administration, chemotherapy often results in unpleasant and possibly dangerous side effects due to drug toxicity. Radiation therapy produces many of the same problems. Most common of such side effects are nausea and vomiting, alopecia (hair loss), and bone marrow depression. Such side effects are usually, but not always, reversible. Some anti-cancer drugs may permanently damage the

nervous system, heart, lungs, liver, kidneys, gonads or other organs. Some chemotherapeutic agents are themselves carcinogenic. Patients undergoing
5 radiotherapy or chemotherapy must also take precautions to avoid what can be life threatening infections in their therapy-induced immuno-suppressed condition.

10 Treatments have been developed to counteract the side effects of cancer radiotherapy and chemotherapy. For example, drugs can be administered to provide some relief from nausea, antibiotics can be administered to help fight infection, and
15 transfusions can be administered to increase blood cell and platelet counts if necessary.

In accordance with this invention it has been found that interferon administered in conjunction with cancer therapy is effective to
20 reduce the undesirable side effects of cancer therapy. The effective route of administration is by contact of interferon in relatively low dosages with the patient's oral and pharyngeal mucosa. It is necessary that the interferon be administered in a
25 form adapted to promote contact with the inside of the patient's mouth and throat in amounts effective to reduce the toxic side effects of cancer therapy, including chemotherapy and radiation therapy.

Detailed Description of the Invention

5 "Interferon" is a term generically
comprehending a group of vertebrate glycoproteins and
proteins which are known to have various biological
activities, such as antiviral, antiproliferative and
immunomodulatory activity, at least in the species of
the animal in which such substances are derived. The
10 following definition of "interferon" has been
accepted by an international committee assembled to
devise a system for the orderly nomenclature of
interferons: "To qualify as an interferon a factor
must be a protein which exerts virus non-specific,
15 antiviral activity at least in homologous cells
through cellular metabolic process involving
synthesis of both RNA and protein." Journal of
Interferon Research, 1, pp. vi (1980). "Interferon"
as used herein in describing the present invention
20 shall be deemed to have that definition and shall
contemplate proteins, including glycoproteins,
regardless of their source or method of preparation
or isolation.

25 Interferons have generally been named in
terms of the species of animal cells producing the
substance (e.g., human, murine, bovine, etc.), the
type of cell involved (e.g., leukocyte,
lymphoblastoid, fibroblast) and, occasionally, the
type of inducing material responsible for the
30 interferon production (e.g., virus, immune).
Interferon has been loosely classified by some

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in the treatment of virus-related disease states. More recently it has been found that exogenous interferon is effective for the regression or remission of some metastatic disease states. An overview of recent clinical trials of interferon as an antiviral and antiproliferative therapeutic agent is contained in Interferon: In Vivo and Clinical Studies, vol. 4, eds. N.B. Finter and R.K. Oldham, Academic Press, New York, 1985. The literature is replete with reports of research and development efforts directed to defining activities and potential therapeutic uses of interferon. Most of the reports described activities of interferon in vitro or its effects in vivo following parenteral, particularly intramuscular and intradermal administration. There have been some reports of successful topical and intranasal usages. It has seldom been administered intravenously because of substantial adverse effects attributable to "contaminants" in crude and even highly purified isolates. While the advent of recombinant DNA technology has allowed production of pure interferon species, intravenous administration of such pure compositions are not without adverse effects. It is noted here that the Food and Drug Administration has approved the use of alpha-interferon administered parenterally in high doses for the treatment of human hairy cell leukemia.

Before Applicant's first report of a successful oral administration of interferon in his

now issued U.S. Patent No. 4,462,985, there was no recognition in the art of the potential offered by oral administration of interferon. The generally
5 held belief was that interferon could not survive the digestive conditions of the upper alimentary canal. Since Applicant's first disclosure of the immunotherapeutic benefit achieved via oral
10 administration of interferon, he has continued to investigate the efficacy of orally administered interferon. In U.S. Patent No. 4,497,795, issued February 5 1985, Applicant described and claimed the
15 use of interferon administered orally or via intravenous administration to stimulate appetite and feed efficiency of animal species. More recently Applicant has described in now pending U.S.
20 applications, the use of interferon at dosages less than about 5 IU/lb of body weight for increasing feed efficiency and food utilization in warm-blooded vertebrates, for preventing and treating shipping
25 fever, and for enhancing vaccine efficiency. Since those earlier applications, Applicant has discovered that the efficacy of orally administered interferon is realized only if it is administered in a form
30 which promotes contact of the interferon dosage with the mucosal lining (possibly macrophages and lymphatics) of the mouth and throat. That discovery in part formed the basis of Applicant's U.S. Patent Application Serial No. 927,834, filed November 6, 1986, titled "Treatment of Immuno-Resistant Disease".

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Human alpha-interferon has been marketed under the trademark Agriferon® by Immunomodulator Laboratories, Inc. ("IML") of Stafford, Texas, for veterinary use in Texas since February, 1985. The product is sold for oral administration to cattle to promote growth and feed efficiency and to prevent or treat viral respiratory infections. IML began selling an alpha-interferon product for horses in 1986. Both products are sold under a license of U.S. Patent 4,462,985. The Amarillo Cell Culture Company, Inc. of Amarillo, Texas markets human-alpha interferon for use in dogs and cats.

The clinical agent of choice for use in the present invention is human leukocyte interferon (human alpha-interferon), mass produced by procedures involving collection and purification of quantities of human buffycoat leukocytes, induction of interferon production with virus, and isolation from culture media. (See "Preparation of Human Alpha-Interferon" below.) Also acceptable for use in accordance with the present invention are human alpha-interferon products produced by recombinant DNA technology and now commercially available from Schering-Plough (as Intron®) and Hoffmann-La Roche (as Roferon®) and approved by the FDA for treatment (parenterally) of hairy cell leukemia of man. Gamma-interferon is also available by recombinant technology and is presently undergoing clinical trials by Genentech, Inc. and others. Fibroblast interferon (beta-interferon) can be prepared in

accordance with Example 1 in Applicant's U.S. Patent
No. 4,462,985, issued July 31, 1984, the disclosure
of which is hereby expressly incorporated by
reference.

Interferon of human and murine origins has
been quantified in the art in terms of International
Units ("IU"). Interferons of other than human or
murine origin can be used in accordance with this
invention, and to the extent that application of
"International Units" to those interferons may be
outside presently accepted practices for
specification of quantities of said interferons, it
shall be understood that amounts of non-human
interferons having the same efficacy as the
quantities (IU's) of human interferon specified in
accordance with this description is within the scope
of the present invention.

In accordance with one preferred embodiment
of the present invention, the toxic side effects
resulting from the administration of chemotherapeutic
agents in a patient receiving chemotherapy for
treatment of cancer are reduced by a method
comprising contacting the oral and pharyngeal mucosa
of said patient with interferon in an amount
effective to reduce said side effects.

Exemplary of chemotherapeutic agents which
are known to produce undesirable side effects in most
patients undergoing chemotherapy for treatment of
cancer include adrimycin, bleomycin, carmustine,
cysplatin, cyclophosphamide, cytarabine (ARA-C),

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dacarbozine, dactinomycin, etoposide, 5-fluorouracil, hydroxyurea, lumustine, mercaptopurine, methotrexate, mytomicin, prednisone, procarbazine hydrochloride, vinblastine and vincristine. Such oncolytic agents are typically used in combination with others listed or other art-recognized chemotherapeutic agents for treatment of neoplastic disease and are all recognized to have contraindications of both acute toxicity and delayed toxicity. Acute toxicity is manifested in side effects such as nausea and vomiting, fever, chills, abdominal pain, hyperglycemia, seizures, diarrhea, hypotension, ventricular arrhythmia, anaphylaxis and localized phlebitis. Delayed toxicity can appear as bone marrow depression and concomitant immuno-suppression, renal damage, thrombosis, alopecia (hair loss), cataracts, liver damage, sterility, hemorrhagic cystitis, pulmonary edema, conjunctivitis, impotence, stomatitis, dermatitis, neurological defects, hypokalemia and hypocalcemia, and the like. Cutaneous reactions, hyperpigmentation and ocular toxicity have been reported with virtually all non-hormonal anti-cancer drugs.

Interferon administered in accordance with this invention has been observed to reduce the side effects resulting from administration of chemotherapeutic agents. The interferon can be derived from human cells or animal cells, or from microorganisms produced by recombinant engineering

techniques to contain one or more functioning genes for human or animal interferon. Proteins having activities similar to natural occurring interferons but with modified amino acid sequences (semi-synthetic interferons) are also contemplated as useful in accordance with this invention.

Interferon is administered to the patient in a dosage form adapted to promote contact with the administered interferon with the patient's oral and pharyngeal mucosa. Thus, the dosage form is preferably in the form of an interferon-containing solution or syrup to be administered and used by the patient in a manner which promotes contact of the interferon component with the oral and pharyngeal mucosa. Alternatively, the interferon can be formulated into a solid dosage form which dissolves when held in the patient's mouth in contact with saliva to release effective amounts of interferon for contact with the oral and pharyngeal mucosa. Other solid or liquid vehicles adapted to accomplish that important function in accordance with this invention can be employed.

Effective dosage levels of interferon for use in accordance with this invention are low compared to levels of alpha-interferon administered parenterally for treatment of some forms of cancer. Thus, while art-recognized dosage ranges for parenteral administration of alpha-interferon for the treatment of human hairy cell leukemia are in excess

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of 10^6 IU per dose, effective doses of interferon in accordance with the present invention are typically less than 1500 IU per dose. Preferably
5 interferon is administered in accordance with this invention at a dosage level of less than 10 IU/lb of patient weight per day and more preferably about 0.1 to about 5.0 IU/lb of patient weight per day. A most
10 preferred dosage is about 1 to about 1.5 IU human alpha-interferon per pound of patient weight per day. Equally effective amounts of human beta-interferon or alpha (or beta) interferon of non-human species origin can be used.

15 Treatment of the patient in accordance with this invention is ideally, although not necessarily, initiated in advance of administration of the chemotherapeutic agents or radiotherapy. Preferably interferon is administered at least one day and
20 better, at least a week prior to beginning cancer therapy. Patient treatment with interferon in accordance with this invention is preferably continued throughout the patient's cancer treatment program.

25 Daily dosage of interferon can be administered as a single dose or, it can be divided and administered as a multiple-dose daily regimen. A staggered regimen, for example 1 to 3 days treatment per week, can be used as an alternative to continuous
30 daily treatment.

Interferon can be administered in accordance with this invention in either a liquid (solution) or

in solid dosage form. Thus interferon can be administered in a buffered aqueous solution typically containing a stabilizing amount (1-5% by weight) of albumin or blood serum. Exemplary of a buffered solution suitable as a carrier of interferon administered in accordance with this invention is a phosphate buffered saline solution prepared as follows: A concentrated (20x) solution of phosphate buffered saline (PBS) was prepared by dissolving the following reagents in sufficient water to make 1000 ml of solution: sodium chloride, 160 g.; potassium chloride 4.0 g.; sodium hydrogen phosphate 23 g.; potassium dihydrogen phosphate 4.0 g.; and optionally, phenol red powder 0.4g. The solution is sterilized by autoclaving at 15 lbs. pressure for 15 minutes and then diluted with additional water to a single strength concentration prior to use.

Alternatively the interferon utilized in accordance with this invention can be formulated into flavored or unflavored solutions or syrups, for example, using a buffered aqueous solution of interferon as a base with added caloric or non-caloric sweeteners, flavors and pharmaceutically acceptable excipients.

A solid dosage form, such as a lozenge adapted to be dissolved upon contact with saliva in the mouth, with or without the assistance of chewing is an equally acceptable means for administering interferon in accordance with this invention. Such a unitary dosage form is preferably formulated to

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5 release about 1 to about 1500 IU of interferon upon
dissolution in the mouth for contact with the oral
and pharyngeal mucosa. Thus a unitary dosage form of
interferon in accordance with this invention can be
prepared by art-recognized techniques for forming
compressed tablets such as chewable vitamins.
10 Similarly, interferon can be incorporated, for
example, into a starch-based gel formulation which
will dissolve and release interferon for contact with
the oral mucosa when held in the mouth. Solid
unitary dosage forms of interferon for use in
accordance with this present invention can be
15 prepared utilizing art-recognized dose formulation
techniques. The pH of such formulations can range
from about 4 to about 8.5.

Preparation of Human Alpha-Interferon

20 Human alpha-interferon can be prepared
through the following procedure, commonly referred to
as the Cantell procedure. The process begins with
packs of human leukocytes, obtained in this case from
25 the Gulf Coast Regional Blood Center, Houston,
Texas. The buffy coats in these packs are pooled
into centrifuge bottles, and then are diluted with
0.83% ammonium chloride. The mixture is incubated
for 15 minutes with intermittent shaking, and is then
30 centrifuged for 20 minutes at 2000 rpm. The
supernatant is discarded, and the cell pellets are
resuspended with a minimal volume of sterile PBS.

5 The mixture is then diluted with ammonium chloride and centrifuged. The supernatant is again discarded, and the remaining cell pellets are resuspended with a minimal volume of a tissue culture medium such as Minimal Essential Medium (MEM), available from KC Biological. The cell concentration is determined with a Coulter counter.

10 Interferon induction takes place in glass or plastic bottles. The induction medium contains MEM, 75mM Hepes (available from Calbiochem), 75mM Tricine (available from Sigma Chemical Co.), human agamma serum (18mg/ml), and gentamycin sulfate (from M.A. Bioproducts; 50mcg/ml). The cells are added to the
15 induction vessels at a final concentration of about 5 to 10 million cells per milliliter. The induction vessel is incubated in a 37°C water bath, and alpha-interferon is added as a primer.

20 After two hours, Sendai virus is added to the induction mixture. This causes alpha interferon to be produced in the supernatant by the leukocytes. After a 12-18 hour incubation time, the induction mixture is centrifuged. The cells are discarded, and
25 the supernatant is then purified.

The crude interferon is chilled to 10°C or below in an ice bath. Five molar potassium thiocyanate is added to obtain a final concentration of 0.5M. This solution is stirred for 15 minutes,
30 and then its pH is lowered to 3.3 by adding hydrochloric acid. The mixture is then centrifuged at 2800 rpm for 30 minutes, and the supernatant is discarded.

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The pellets are then resuspended in 95% ethanol and are stirred for 15 minutes. This suspension is centrifuged at 2800 rpm for 20 minutes, and the pellets are discarded. The pH of the supernatant is then adjusted to 5.8 with sodium hydroxide. The mixture is stirred for 10 minutes, and then centrifuged at 2800 rpm for 20 minutes. The pellets are discarded. The pH of the supernatant is then adjusted to 8 with sodium hydroxide. This solution is stirred for 10 minutes, followed by centrifugation at 2800 rpm for 20 minutes. The supernatant is discarded, and the pellets are resuspended with 0.5M potassium thiocyanate in a 0.1M sodium phosphate buffer. This suspension is stirred at 4°C.

Next, the suspension is centrifuged at 2800 rpm for 20 minutes, and the pellets are discarded. The pH of the supernatant is adjusted to 5.3 with hydrochloric acid. After stirring for 10 minutes and centrifugation, the pH of the supernatant is adjusted to 2.8 with hydrochloric acid, followed by further stirring for 20 minutes. This mixture is centrifuged at 2800 rpm, and the resulting pellet is purified human alpha-interferon.

The pellet is resuspended with 0.5M potassium thiocyanate in 0.1M sodium phosphate buffer, having a pH of 8.0. It is then dialyzed against PBS at 4°C, with two changes of PBS. This mixture is then centrifuged and the precipitate is

discarded. The remaining purified alpha interferon
is sterilized by filtration through a 0.2 micron
5 filter. A human alpha-interferon has been produced
in accordance with this procedure by Immuno
Modulators Laboratories, Inc., Stafford, Texas, and
sold under the trademark Agriferon® for use in
cattle and Equiferon® for use in horses.

10 Other procedures known to those skilled in
the art are available for making interferons, such as
human alpha-interferon and human gamma-interferon.
For example, U.S. Patents 4,376,821 and 4,460,685
disclose methods of making human gamma-interferon. A
15 method of making bovine fibroblast (beta) interferon
is disclosed in applicant's U.S. patent 4,462,985.

EXAMPLE 1

20 A 40-year old, 150 pound male patient (R-1)
suffering from an adenocarcinoma underwent surgery to
remove a major portion of one lung and proximal lymph
glands. He was subjected postoperatively to maximum
allowed dose of Cobalt-60 radiation therapy. Routine
25 postoperative fluroscopic examination 5 months after
surgery revealed new tumor growth in lung tissue.
Patient R-1, having been informed by his oncologist
of a poor prognosis, sought other therapeutic methods
for treatment of his cancer.

30 R-1 initiated a carefully maintained dietary
regimen which in general terms was a vitamin and

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herbal supplemented, low fat diet. R-1's regimen further included a daily dosage of about 150 IU of human alpha-interferon (Cantell) in phosphate buffered saline (150 IU/ml) taken into his mouth for contact with his oral and pharyngeal mucosa. The solution was administered using a 3-ml syringe to direct the interferon solution onto the mucosa lining the mouth. R-1 used his tongue to manipulate the interferon-containing solution in his mouth to maximize contact with the oral and pharyngeal mucosa. Within one week of the initial low dosage of interferon, R-1 noted a significant improvement in a congestive respiratory condition that had troubled him during and subsequent to radiation therapy.

R-1 continued his daily self-administered dosages of interferon solution up until a time immediately proceeding his participation in a study of a new, experimental oncolytic agent at a major midwestern medical center. The study involved treatment with an unidentified experimental drug in patients receiving, at the same time, other known oncolytic agents. R-1 received treatments with the experimental drug in conjunction with the administration of 5-fluorouracil. R-1 experienced markedly less toxicity effects (nausea and intestinal discomfort) than did other patients receiving the same therapy. R-1 was nauseous for no more than one hour following his completion of intravenous

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administration of the drugs under study. He was able to undergo therapy on an outpatient basis, and he reports that he was able to work at home between his daily visits to the medical center for chemotherapy. His oncologist commented both on R-1's ability to withstand the experimental therapy with markedly reduced nausea compared to other patients in the study and on the results of R-1's blood analysis. R-1's white cell counts, while being reduced as expected by the chemotherapy, rebounded to normal levels much more rapidly than those in other patients in the study.

R-1 resumed his dosages of interferon as described above following participation in the first study. R-1 participated later in a second experimental study conducted to determine efficacy of a chemotherapeutic agent reportedly consisting of a chemotherapeutic agent coupled to monoclonal antibodies. Again R-1's oncologist noted and commented on R-1's much reduced pain, less nausea, and fewer symptoms attributed to the chemotherapy toxicity compared to those symptoms reported by other patients receiving the same experimental therapy.

EXAMPLE 2

A 6-year old male (N-1) suffering from acute myelogenous leukemia was treated to remission over a 3-4 month period using a chemotherapeutic regimen consisting of cytosine arabinoside (Ara-C),

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daunomycin, VP-16 (etoposide), 6-thioguanine and dexamethasone in the induction phase of treatment. During that induction phase N-1 experienced all of the characteristic side effects of chemotherapy including hair loss, nausea and vomiting, and bone marrow depression. Once N-1's leukemia was in remission he initiated a vitamin supplemented dietary regimen which included specifically daily amounts of vitamin C (1000 mg), Vitamin E (400 IU) and selenium supplement (50 mcg). N-1's weight is about 50 pounds.

Following the induction phase of N-1's treatment program, the second phase, the consolidation phase, of chemotherapy was initiated. The consolidation phase consists of several courses of cyclic chemotherapy combined with intrathecal drug administration to prevent leukemia of the central nervous system. In Course 1 of the consolidation phase, N-1 was given two treatments, 7 days apart, each consisting of four high doses of Ara-C given twelve hours apart followed by L-asparaginase. N-1 experienced the expected toxic effects of such therapy, including nausea, vomiting and bone marrow depression. Course 2 of the consolidation phase consists of 1 monthly regimen of 6-thioguanine orally for 28 days, vincristine sulfate i.v. for one day; Ara-C, 5-azacytidine and cyclophosphamide i.v. for four days. During the last four days of the first monthly regimen (i.v. administration phase), N-1 was

very sick; he experienced significant nausea and vomiting on each day of i.v. drug administration.

5 Following that first phase of the second
course of consolidation, N-1 began contacting his
oral and pharyngeal mucosa daily with about 100 IU of
human-alpha interferon (Cantell) administered in
about 1 ml of a solution in sterile phosphate
10 buffered saline. The solution was self-administered
daily from a syringe from which it was discharged
against the lining of the mouth and moved with the
tongue to maximize contact with the oral and
pharyngeal mucosa. During the i.v. administration
15 phase of the second month of the second course of
consolidation, N-1 experienced nausea and vomiting
only on the first day of i.v./intrathecal drug
administration. N-1 was able to eat regularly and
play at home on each subsequent day of
20 i.v.-chemotherapy.

25 N-1's oncologist has commented on N-1's high
energy level, his lack of hair loss and less nausea
and the rapid recovery of his white cell counts
following chemotherapy compared to other patients at
his age and stage of chemotherapy.

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EXAMPLE 3

5 A 38-year old, 160 pound male patient (F-1)
was diagnosed as positive for Kaposi's Sarcoma (KS)
in October, 1986. F-1 was initially treated with
vincristine, vinblastine and etoposide. Later F-1
10 was treated with vincristine (0.5 mg), vinblastine
(2mg), and bleomycin (5 units). Toxicity from
therapy included painful oral ulceration, loss of
appetite, nausea, and fatigue. F-1 added to his
regimen a biweekly daily dosage of about 150 IU of
15 human alpha-interferon (Cantell) in phosphate
buffered saline (150 IU/ml) taken into his mouth for
contact with his oral and pharyngeal mucosa. The
solution was administered using a 3-ml syringe to
20 direct the interferon solution onto the mouth.
Within one week of the initial low dosage of
interferon, F-1 noted a significant reduction of oral
ulcers, improvement of appetite, weight gain, and an
improved energy level compared to the toxicity which
had troubled him during and subsequent to his therapy.

25 F-1 continued his intermittent
self-administered dosages of human interferon
solution up until a time he switched to bovine
alpha-interferon (obtained from cattle nasal
secretions). Bovine alpha-interferon relieved the
toxicity of his weekly chemotherapy even more
30 completely than human alpha-interferon. The
combination of interferon and chemotherapy has
resulted in complete remission of KS.

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10. The method of claim 9 wherein the interferon is alpha-interferon administered daily during cancer therapy.

11. The method of claim 10 wherein the interferon is administered daily beginning at least one day prior to initiation of chemotherapy.

12. The method of claim 1 wherein the interferon is administered in a dosage form adapted to be held in the patient's mouth for a period of time to maximize contact of the interferon with the oral and pharyngeal mucosa of said patient.

13. The method of claim 1 wherein the interferon is administered in the form of an interferon-containing solution.

14. The method of claim 1 wherein the interferon is administered in the form of a lozenge.

15. Method for treating a cancer patient to reduce the undesirable side effects of cancer chemotherapeutic agents, said method comprising the step of contacting the oral and pharyngeal mucosa of said patient with interferon in an amount effective to reduce said side effects.

16. The method of claim 15 wherein about 0.1 to about 5 IU of interferon per pound of patient body weight is administered daily beginning at least one day prior to initiation of chemotherapy.

17. Method for reducing radiation-induced side effects in a patient undergoing radiation therapy for the treatment of cancer, said method comprising the

step of contacting the oral and pharyngeal mucosa of said patient with interferon in an amount effective to reduce said side effects.

18. The method of claim 17 wherein about 0.1 to about 5 IU of interferon per pound of patient body weight is administered daily beginning at least one day prior to initiation of chemotherapy.

19. The method of claim 17 wherein the interferon is human alpha-interferon.

20. The method of claim 17 wherein the interferon is interferon of a non-human species or a semi-synthetic interferon.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/00024

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC (4): A61 K 45/02 U.S.C1. 424/85.6, 85.7											
II. FIELDS SEARCHED <div style="text-align: center; margin-top: 5px;">Minimum Documentation Searched ⁷</div> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <th style="width: 20%;">Classification System</th> <th style="width: 80%;">Classification Symbols</th> </tr> <tr> <td style="text-align: center; vertical-align: top;">US</td> <td style="text-align: center; vertical-align: top;">424/85.4, 85.5, 85.6, 85.7</td> </tr> </table> <div style="text-align: center; margin-top: 5px;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸</div>			Classification System	Classification Symbols	US	424/85.4, 85.5, 85.6, 85.7					
Classification System	Classification Symbols										
US	424/85.4, 85.5, 85.6, 85.7										
Online Computer Search of Chemical Abstracts 1967-1989 Search terms: alpha or beta interferon and cancer											
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <th style="width: 10%;">Category [*]</th> <th style="width: 70%;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td style="vertical-align: top;">Cancer Research, Volume 46, issued September 1986 (U.S.A.) GOLDSTEIN, "Interferon Therapy in Cancer: From Imaginon to Interferon". See pages 4315-4329.</td> <td style="text-align: center; vertical-align: top;">1-20</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td style="vertical-align: top;">Journal of The National Cancer Institute, Volume 51, issued September 1973 (U.S.A) STRANDER, "Clinical and Laboratory Investigation on Man Systemic Administration of Potent Interferon to Man". See pages 733-742.</td> <td style="text-align: center; vertical-align: top;">1-20</td> </tr> </table>			Category [*]	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	Cancer Research, Volume 46, issued September 1986 (U.S.A.) GOLDSTEIN, "Interferon Therapy in Cancer: From Imaginon to Interferon". See pages 4315-4329.	1-20	X	Journal of The National Cancer Institute, Volume 51, issued September 1973 (U.S.A) STRANDER, "Clinical and Laboratory Investigation on Man Systemic Administration of Potent Interferon to Man". See pages 733-742.	1-20
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>[*] Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>											
IV. CERTIFICATION <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <td style="width: 50%; vertical-align: top;"> Date of the Actual Completion of the International Search 22 March 1989 </td> <td style="width: 50%; vertical-align: top;"> Date of Mailing of this International Search Report 26 APR 1989 </td> </tr> <tr> <td style="vertical-align: top;"> International Searching Authority ISA/US </td> <td style="vertical-align: top;"> Signature of Authorized Officer Blondel Hazel </td> </tr> </table>			Date of the Actual Completion of the International Search 22 March 1989	Date of Mailing of this International Search Report 26 APR 1989	International Searching Authority ISA/US	Signature of Authorized Officer Blondel Hazel					
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